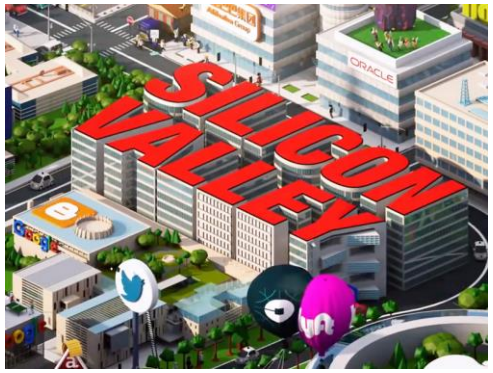
#DISRUPTME210

ME210 Project, Winter 2018
Project Performance Check-off *at any time before* 2018-03-09 16:00
Project Presentations on Sunday, 2018-03-11, 19:00 in the 550 Atrium

Introduction

"We're not like every other Silicon Valley startup"
— every single Silicon Valley startup



You've already spent countless hours in the ME210 lab, making friends with Sparkis, building signal conditioning circuits, and driving stepper motors - but the real fun has yet to begin. With your newfound ME210 knowledge, you've now decided to form a team of world-class innovators and launch a startup. What better place to do that than right here in the d.school? Your startup is the best startup. You know it. Everyone knows it. But the VC's only have enough funding for one new project after the crypto crash of '18, and everyone in Silicon Valley wants it. You'll have to go head-to-head with other Startups to make your business succeed. You will need to gather series A and B funding and acquire your opponent for a victory. It seems like every other day another startup joins the unicorn list, reaching over a $1B valuation, and the next one could be yours! The purpose of this project is to provide you with an opportunity to apply what you have learned so far in ME210 to solve an open-ended mechatronics design problem. The task is to design an autonomous machine that will compete against an opponent in a miniature mechatronic sport. This document uses a lot of project specific terms; please take a look at the Glossary of Terms before continuing.

Project Specification Summary

The game is played by collecting Buzzwords and pitching them to VC's by placing them into bins for each Funding Round. Acquiring rounds of funding will cause your GATE to open, indicating that your company has made its IPO and giving you the means to acquire your opponent's Startup Garage. You win the game by either acquiring your opponent's Startup Garage or collecting more Buzzwords than your opponent if neither of you are able to acquire the other Startup's Startup Garage before the timer expires.

Each Startup's **R**evolutionary **O**n-site **B**usiness **O**pportunity **T**hingamabob (ROBOT) will start the game at their Startup Garage with 4 Buzzwords already loaded. More Buzzwords can be obtained at any time during the round by navigating to your Startup's Incubator, where a member of your startup will manually load Buzzwords into your ROBOT when the Buzzword Generator has been activated. A method of your choosing may be used to deposit Buzzwords in the Funding Rounds. You may also steal Buzzwords from your opponent's side of a Funding Round by tipping the Funding Round down on your side of the FIELD (you underhanded monster). Gameplay proceeds as follows: your ROBOT begins in its Startup Garage, and must first acquire series A funding by tipping Funding Round A towards your team's side of the FIELD. Once series A has been secured, you will have the opportunity to begin pitching for series B funding (Funding Round B will become active), and/or to file for patent protection at The Patent Office. In order to win the game, your ROBOT must simultaneously have control of Funding Round B and either Funding Round A or The Patent Office. In order to win control of your Funding Round B you must deliver more Buzzwords to the VC firm than your opponent used to win their series A.

Once your ROBOT controls Funding Round B and either Funding Round A or The Patent Office, the GATE will open, allowing you to go through to acquire your opponent's Startup Garage and win the round. If at any point, however, your opponent acquires more funding or intellectual property than you, the GATE will close and you will not be able to acquire your opponent. In this case, your ROBOT will need to return to the Incubator, grab some more Buzzwords and use them to regain the funding or intellectual property advantage needed to re-open the GATE. Should the timer expire before either ROBOT has acquired their competitor, the team with more funding and intellectual property will win by default. On each side of the game board, there is a line of black, non-reflective tape running from the Startup Garage to the GATE. Along this tape line, there are gray strips of semi-reflective tape perpendicular to the black tape line in front of each of the Funding Rounds. There is another black tape line running from the Startup Garage to the Incubator. Above Funding Round A, Funding Round B, the GATE, and the Incubator, there are Beacons flashing at different frequencies. The Patent Office does not have a Beacon. In order to reload your ROBOT, it must press the Buzzword Generator, which is a limit switch located in the Incubator at the edge of the board.

SCHEDULE OUTLINE

- **First Review: February 20 in class (T+5 days)**
- **Second Review: February 27 on Canvas (T+12 days)**
- **First Checkoff: March 1 by 23:59 (T+14 days)**
- **System Integration Checkoff: March 6 by 23:59 (T+19 days)**
- **Project Preview: March 8 in class (T+21 days)**
- **Final Performance Checkoff: March 9 by 16:00 (T+22 days)**
- **Competition: March 11 at 19:00 (T+24 days)**

Project Advice

Each Startup will consist four (or maybe three) members. There is a lot of work to be done and a finite amount of time, but don't panic (or do, I'm not a cop). The following tips should help you stay on top of things while getting the most out of the experience:

- Start early (now, start now).
- Spend a lot of time perfecting your state machine, hammering out your design, agreeing on your interfaces, and picking your components. These will be the foundation for your code, and programming your robot will go a lot faster if you do these things well.
- Get out of your comfort zone. If you don't have experience with a concept or device, working on it during the project will be a great learning opportunity. For example, if you are a CS major, do not spend all of your time coding; instead work on signal conditioning or mechanical design.
- Work together and communicate. It's tempting to divide and conquer, but your teammates can't help you if they don't understand what you're working on.
- Sleep. You think you'll get more done if you stay up for 48 hours straight beating your head against the data sheet for your motor driver, but you're wrong. And take a shower, you smell like duron and dirty feet.
- Know where to find emergency replacement parts. If you don't have time to wait for a shipment, Jameco, Fry's (did you know Fry's will haggle prices?), and room 36 can save your project, for a price (be wary of but receptive to blood contracts).

Project Specification Details

The following section contains a detailed description of the rules and regulations for each aspect of this tournament. Please read this carefully, and feel free to consult with the teaching team to clarify any ambiguities.

ROBOT REQUIREMENTS

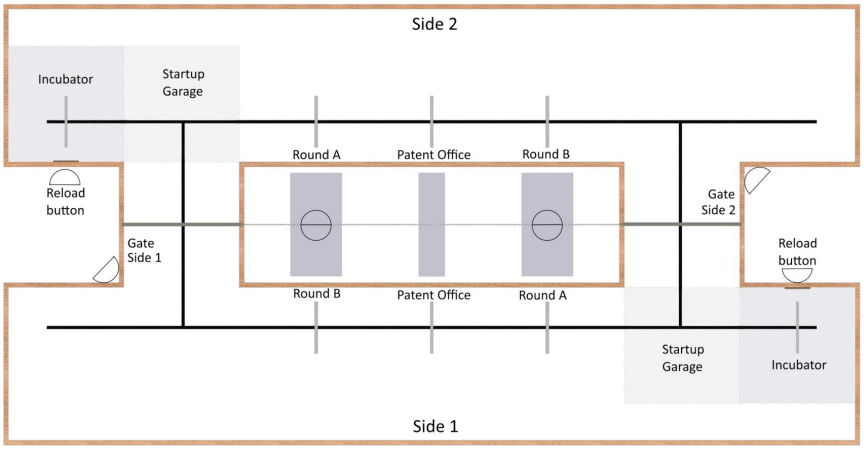
- Each student team will be responsible for designing, building, and demonstrating their own ROBOT. The ROBOT is an autonomous machine which will compete in the game according to the specifications and rules defined in this document.
- Each ROBOT must be a stand-alone entity, capable of meeting all project specifications, and must operate completely untethered during grading and competition.
- Each ROBOT shall incorporate an easily accessible toggle switch on its exterior which will serve as an emergency stop switch. The switch must cut all power to the machine when toggled.
- Each Startup may incorporate an external switch on their ROBOT to indicate to their ROBOT which Startup Garage they will start the game on.
- The ROBOT's control software should be executed from the flash memory of one or more Teensy microcontrollers. Computers will not be permitted to be tethered to the ROBOT during its operation. Consult with the teaching team if you have a strong preference for using a different microcontroller. Should you decide to use a different microcontroller, the teaching team will not provide support for debugging microcontroller-related issues.
- Power for the ROBOT must be supplied by batteries, which are to be carried on board each ROBOT. Each team will receive two 7.2V NiMH rechargeable battery packs. Expect to charge these often. Use of circuit breakers is mandatory. We will provide one circuit breaker which will allow you to start up motors (it accepts short current surges). Additional NiMH batteries may be used if desired, and may be purchased from the stockroom (depending on availability).
- Use of Li-ion, LiPo, and Lithium primary batteries is strictly forbidden, as is the use of live grenades, Samsung galaxy note 7 tablets, beached whale carcasses, and any other explosive device.
- ROBOTs are limited to a maximum capacity of 4 Buzzwords.
- ROBOTs must be robust to all normal game interactions - including, but not limited to: collisions with any part of the FIELD, stray projectile Buzzwords, and old, sad Buzzwords meandering aimlessly about the FIELD.
- Each ROBOT must be constructed as part of ME 210 activities during the remainder of the quarter. It may not be based on a commercial or otherwise pre-existing platform. Rulings from a member of the teaching team may be requested if there are questions about the content of your ROBOT.
- Each team must adhere to an expenditure limit of US $200 for the materials and parts used in the construction of the project. The cost of the two provided NiMH battery packs, fuses/circuit breakers, and the lab kit components (including a single Teensy per team member) do not count towards this limit.

THE FIELD

- ROBOTs will compete on a FIELD (see Figure 2) consisting of two 11' by 23.5" halves 18" apart, connected by bridges that are 18" wide. The FIELD is constructed from particle board uniformly covered with white laminate. Black and grey tape on the surface and IR Beacons placed at specific locations will help your robot navigate.
- The FIELD is surrounded by a wall consisting of 3/4" wide wooden boards that are 4" tall relative to the playing surface.
- Each ROBOT starts at a Startup Garage (an 18" by 18" zone) on their side of the field, in an orientation of the team's choosing.
- Lines of black tape lead from the Startup Garage past the Funding Rounds and the GATE, at a distance of 6" from the wall. The line also leads to the Incubator, as shown in the figure below. Lines also connect the two sides, running along the middle of the bridges. The position of each Funding Round will be indicated by a segment of gray tape, running perpendicular to the line of black tape.
- Beacons, denoted by semicircles in the below figure, are placed 10" above the playing surface and indicate the status and position of the Funding Rounds, the

GATEs and the Incubator.

- The only way out of your side of the FIELD is to cross the bridge to the other side. The bridges are protected by GATEs that will only open when your ROBOT succeeds in its IPO.
- A net above the center of the field will prevent Buzzwords from crossing over to the other side over the Funding Rounds.
- Each half of the field contains a Incubator. The Incubator is an 18” by 18” zone next to the wall with a button mounted on the wall, 2” above the playing surface. The button is 4” wide and 2” tall. Teams may reload their ROBOTs manually when this button is pressed and the ROBOT is inside the Incubator.



FIELD Layout Diagram[1]

THE BUZZWORDS

- The Buzzwords are spheres with a 1” diameter. Just like in real life, the amount of buzzwords you pitch is directly proportional to your Startup’s likelihood of success.

THE PATENT OFFICE AND FUNDING ROUNDS

- ROBOTs will deposit Buzzwords into the Funding Rounds in order to secure funding for their Startup.
- The Funding Rounds (bins) are 8” wide, 17” long (stretching between the two sides of the field), and 2” deep.
- The Funding Rounds can tip 10◦ in either direction.
- Once the Funding Rounds are tipped to a side, all Buzzwords in either side of the Funding Round go to the tipped side.
- The Patent Office functions similarly to the Funding Rounds except that Buzzwords cannot be stolen, and will always remain on the side on which they were deposited. Therefore, The Patent Office functions more as a scale than a see-saw.
- The Patent Offices are 4” wide, 17” long and 2” deep.

THE GATES

- The GATEs are the barriers which prevent your ROBOT from reaching the other side of the FIELD and winning the game.
- The GATEs are impenetrable barriers of the same height as the barriers surrounding the FIELD (3.5”).
- The GATE will open by swinging up vertically at the outer edge of the FIELD when the appropriate condition is achieved by your ROBOT.
- The GATE will have an IR beacon at the outer edge of the GATE and at a height of 10 inches above the FIELD. The Beacon will be switched on only when the GATE is in the fully open condition.
- Any purposeful effort to block or force the motion of the GATE will result in disqualification or failure to check off. Note that if your ROBOT is in direct physical contact with the gate before it is fully open, it may be unable to continue to open, impairing your ability to win the round.

THE BEACONS

- The Beacons are bright infrared (IR) emitters modulated at a particular frequency and duty cycle (square wave). The Beacons may be detected with a standard IR phototransistor and signal conditioning circuit (similar to lab 1).
- The Beacons are approximately omni-directional, and may be detected from anywhere on your side of the FIELD.
- The Funding Round A Beacon will be set to 950 Hz, and is always on. The duty cycle may optionally be read to learn the status of Funding Round A (50% - neutral position, 75% - winning, 25% losing).
- The Funding Round B Beacon will be set to 1350 Hz, and will be turned on after Funding Round A has been tipped to your side of the FIELD. The Funding Round B Beacon will then remain on for the remainder of the game. The duty cycle indicates the status of Funding Round B in the same manner as Funding Round A.
- The Incubator Beacon will be set to 3500Hz and is always on.
- The GATE Beacon will be set to 4125 Hz and is on when the GATE is fully open.
- The height of each Beacon will be 10” from the floor of the FIELD.
- Sample Beacons will be made available at the start of the project for development and testing purposes.

BEACON	FREQUENCY (Hz)

[1] A full-sized diagram is attached in the Appendix at the end of the document for convenience and improved readability.

FUNDING ROUND A	*950*
FUNDING ROUND B	1350
STARTUP INCUBATOR	3500
GATE	4125

Rules of Engagement

"We move fast and break things."
— 2017 most frequently-used phrase on AngelList

- Rounds last for 2:10. The first ROBOT to reach its opponent's Startup Garage will be declared the victor. If neither ROBOT is able to accomplish this, the Startup which has the most Buzzwords in its Funding Rounds when 2:10 expires will be be declared the victor. The victor will then advance to the next round.
- ROBOTs must automatically cease game play 2:10 after the start of a round.
- ROBOTs must show good sportsmanship: any celebratory actions or displays prior to the end of the game will be penalized, and we will be very, very disappointed in you.
- Each ROBOT is placed inside its team's Startup Garage at the start of the game. ROBOTs may start the game preloaded with up to 4 Buzzwords.
- The initial orientation of each ROBOT may be decided by its Startup.
- An auditory start command will be issued by a member of the teaching team, at which time a member of each team will actuate a button, switch, guilded lever, rip cord, or other simple indicator on their ROBOT which will initialize game play. This is the last human interaction permitted with the ROBOT until 2:10 has elapsed. The only exception is for reloading Buzzwords into the ROBOT while it is at the Incubator and handling emergencies as determined by the teaching team.
- Emergencies will be announced through panicked screaming and frantic hand gestures.
- Buzzwords may be placed in The Patent Office and the Funding Rounds using any method of your choosing, so long as it falls within project specifications (e.g. no combustion-powered cannons).
- ROBOTs may interact with The Patent Office and the Funding Rounds in any way they choose, so long as they do not damage them.
- Because the Funding Rounds tilt back and forth, the Buzzwords in them will slide toward the lower side of the Funding Round. Buzzwords only count for your Startup while they are in a Funding Round and also on your Startup's side of the FIELD.
- Although The Patent Office also tilts back and forth, a center barrier will prevent points scored in The Patent Office from being stolen by the other Startup.
- ROBOTs may navigate to the Incubator at any time to be reloaded with up to 4 Buzzwords by a human member of the Startup. ROBOTs must be completely within the boundaries of the Incubator while reloading.
- No part of the ROBOT may be within the boundaries of the Incubator while attempting to place Buzzwords in The Patent Office or the Funding Rounds.
- Once the game begins, the first step of the game is to tilt Funding Round A towards your side of the field. This will cause Funding Round B to become active. Funding Round B will remain active for the remainder of the game.
- After Funding Round B has become active, ROBOTs will be able to open the gate:
    - Your GATE will open once both Funding Round B and either Funding Round A or The Patent Office are tilted toward your side of the FIELD.
    - If, after opening, Funding Round B or both Funding Round A and The Patent Office tilt towards the opponent's side, the GATE will close. The GATE will open again once the above conditions are met.
- While your Startup's GATE is open, you may navigate to your opponent's Startup Garage. The GATE will not close while your ROBOT is in its path.
- Reaching your opponent's Startup Garage ends the game and results in victory.
- Intentional destruction, damage, or alteration of any part of the FIELD or other ROBOTs is expressly forbidden.
- Intentional jamming of your opponent's sensing abilities is prohibited.
- Your robot should be robust to interaction and collision with both the FIELD and other ROBOTs, as there may be collisions when both teams are on the same side of the field.
- No part of the ROBOT may become ballistic and leave the FIELD. Buzzwords are not considered part of the ROBOT.
- No part of your ROBOT may be left behind in The Patent Office or the Funding Rounds during the game.
- The competition seed position will be determined by the order in which Startups performed the graded check off (see performance requirements).
- Human Startup members are also not allowed to position themselves in a way that will interfere with the activities of the opponent's ROBOT. Polite, "G-rated" heckling is permitted, of course.

Performance Requirements

- For the purposes of grading, the minimum requirement for each ROBOT is to "beat a brick" (the standard, inanimate ME210 check-off opponent). Specifically, each machine must open up its GATE by depositing at least one Buzzword each into Funding Round A and Funding Round B, and then navigate its way through the opened GATE to the opponent's Startup Garage. This all must take place within 2 minutes and 10 seconds, when competing against a literal brick.
- Your team may check off at any moment of your choosing, day or night, as long as there is at least one member of the teaching team present as a witness. The teaching team would greatly appreciate some advance notice of an attempt to

check off, as many of them are lurking nearby and will materialize to witness your success. If disaster strikes ("Its never done THAT before!?!!"), and your ROBOT fails to check off, you will subsequently be required to perform two successive check-offs at a time of your choosing. If either of these consecutive check-off attempts fails, you will be required to perform three successful checkoffs. Lastly, check-off must be completed for all teams no later than 16:00 on Friday, March 9.

- It is important for everyone to remember that **the minimum performance requirement is the goal for the class**. There are no "extra credit" points awarded for performance above this minimum. Student teams are strongly encouraged to strive for demonstration of the minimum performance functionality as early as reasonably possible, so that the members of these teams may return to their regularly-scheduled lives.
- The results of the tournament held at the public presentation session will not affect grading. The public presentation is purely an opportunity for you to enjoy the devices you've created, and to show your friends and loved ones why you have disappeared for 3 weeks.

Essential Guidelines for Safety

- All projects shall respect the spirit of the rules, as established in this specification and in the culture of ME210. If you are considering something that may bend or violate the rules, you must first consult with a member of the teaching staff. Interpretations and rulings are the sole domain of the teaching staff.
- All machines and devices must be safe to users, to the lab, and to any spectators.
- High speed projectiles are not permitted; if your ROBOT launches Buzzwords, they should not be traveling fast enough to cause bodily harm or structural damage.
- The powers of the Teaching Staff to protect ME210 and its participants are very substantial and shall not be questioned.
- Tolerances on the dimensions of the FIELD are ±1 inch unless otherwise specified.
- Once the FIELD is constructed, its dimensions supersede any dimensions published in any documents.
- Although ungraded, teams are encouraged to use creative themes and aesthetics for their ROBOTs and themselves.
- Pyrotechnics and combustion of any kind are prohibited.
- A main circuit breaker/switch will be provided and must be used as a main power shut down. When the switch is in the off position, all power must be disabled, and no subsystems may remain energized.

Evaluation

"(╯°□°)╯ ┻━┻"

—You

"¯_(ツ)_/¯"

—The Brick

GRADING CRITERIA

1. **Concept (25%)** This will be based on the technical merit of the design and programming for the machine. Included in this grade will be evaluation of the appropriateness of the solution, as well as innovative hardware and software and use of physical principles in the solution.

2. **Implementation (25%)** This will be based on the machine displayed at the evaluation session. Included in this portion of the grade will be evaluation of the physical appearance of the machine and the quality of its construction. Aesthetics will not be judged, rather, craftsmanship and finished appearance are the focus of this portion.

3. **Performance (25%)** Based on the results of the performance during the evaluation session.

4. **Coach Evaluations (10%)** Based on the four project milestone reviews (see below).

5. **Report (15%)** This will be based on an evaluation of the final report. It will be judged on clarity of explanations, and on the completeness and appropriateness of the documentation. This report should be prepared in HTML format (as a website), and submitted as a compressed ZIP archive on Canvas ready for publication on the Internet.

DOCUMENTATION REQUIREMENTS

- Each design team shall maintain a logbook, which may be in electronic format.
- At a minimum, this logbook shall contain up-to-date mechanical, electrical, and software documentation. This is expected to also include things such as task lists, schedules, sketches, notes from brainstorming meetings, solid models, schematics, code listings, notes about software and hardware versions, and the like.
- It is acceptable for the logbook to be a collection of links to various collaboration SaaS tools such as Asana, Trello, OnShape, Gdrive, GitHub, etc. as long as every team member has access to all of such tools at all times.
- An HTML-based final report describing the technical details of your machine is required.
- The report shall include sufficient detail that a person skilled at the level of ME210 could understand, reproduce, and modify the design.

- You must turn in the actual HTML source code and all assets for your report, rather than building a site on a third-party host and linking to it. Assume that your site will be reviewed on a computer not connected to the Internet.
- Using software tools to edit HTML in ways other than editing the code directly is permitted, as long as the final submission is in HTML format.
- These reports will be posted on the public ME210 website in the future, so please make sure that the content is appropriate and do not disclose information that you do not wish to be made permanently public.

A NOTE ON RESOURCE PLANNING

This is a *mechatronics* project design activity. While aspects of electronics and software design were emphasized this quarter, it is important to realize that *any mechatronic project also requires substantial mechanical design*. Grading in this class is based on complete system design and function. Therefore, a "beautiful" electronics system is not a successful project if the mechanical part of the machine fails. Be certain to allocate resources (energy, time, and people) to all aspects (including mechanical) of this project.

Project Milestones

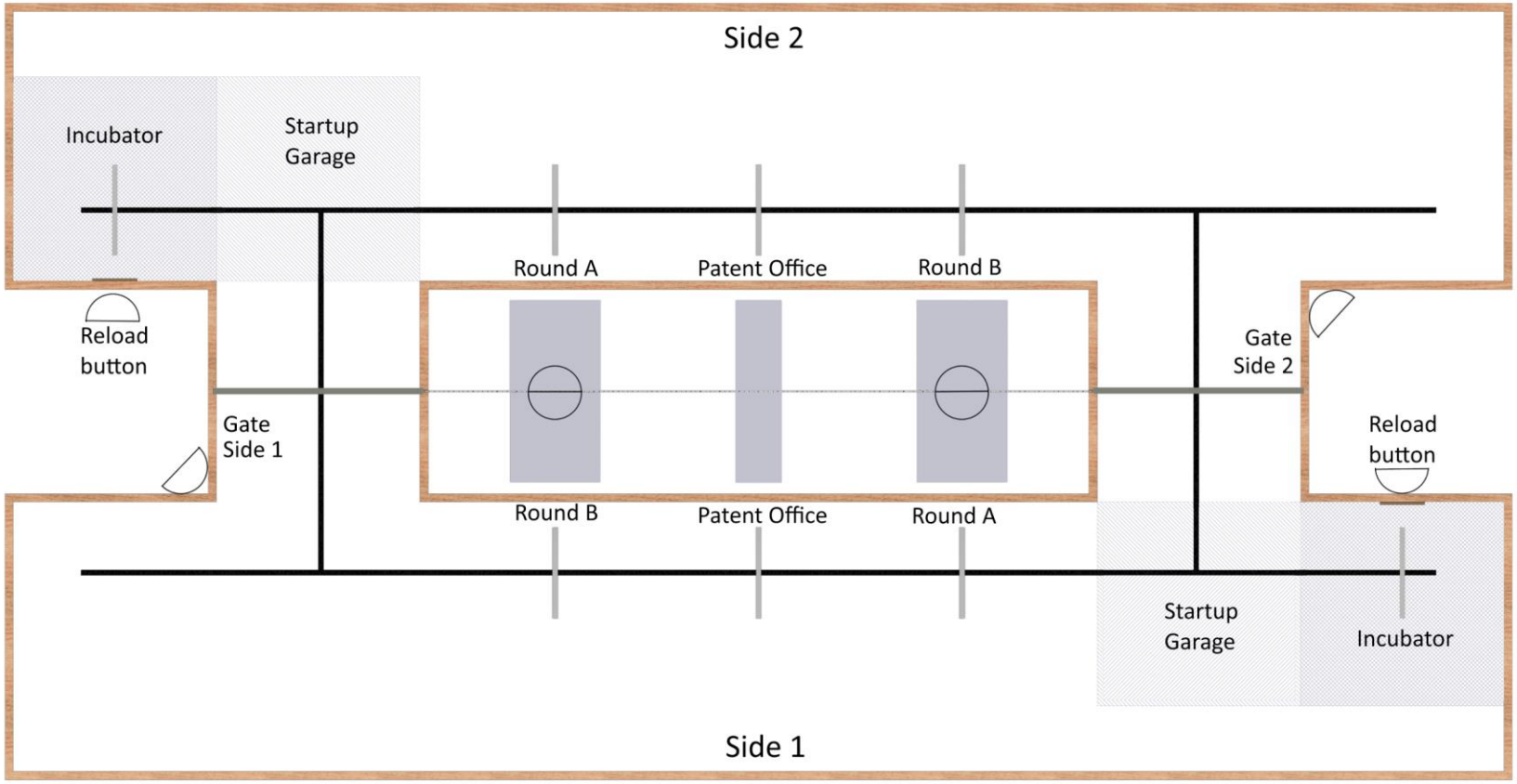
MILESTONE	DELIVERABLES
First review In Class Tuesday, 2018-02-20 09:30	*Computer presentation of ~8-10 min. duration* At most 4 slides with at least 4 design concepts (can be of entire robot or of relevant subsystems), with sketches Time schedules, project plan/variances Personnel assignments
Second Review by Tuesday, 2018-02-27 23:59	*Turn in documentation (Lab or Canvas)* Calculations System block diagram Preliminary testing results
Third Review by Thursday, 2018-03-01 23:59	*Presented to coach; check-off by teaching staff* Demonstration of all functional subsystems per block diagram: ball delivery, beacon sensing, tape sensing, mobile platform, etc.
Fourth Review by Tuesday, 2018-03-06 23:59	*Check-off by teaching staff* Integration of subsystems Working software to test all systems Working versions of all systems
Grading Session by Friday, 2018-03-09 16:00	*Check-off by teaching staff* Demonstrate minimum functionality on the playing field set up in the lab or in the 550 Atrium
Final Presentations Sunday, 2018-03-11 19:00	*Public presentation and tournament in the 550 Atrium* Finished, operational, presentable machines
Project Preview In Class Tuesday, 2018-03-13 09:30	Bring your finished project to class for an up-close review by classmates and teaching staff
Final Report by Friday, 2018-03-16 17:00	HTML format Suitable for publishing on ME210/SPDL website

Glossary of Terms

- ROBOT: Revolutionary On-site Business Opportunity Thingamabob – your robot
- FIELD: Financial Institution for the Evaluation of Lucrative Designs
- GATE: Guillotine of Asset TransfErral – a moving barrier which restricts access to the opponent's side of the FIELD

- Buzzword: 1” diameter wooden balls covered with text, the buzzword(s)
- Funding Round: bins that your ROBOT places Buzzwords into
- Funding Round A: the first bin your ROBOT must tip
- Funding Round B: the second bin your ROBOT must tip, after the first bin is tipped
- Incubator: a taped off area that your robot must be inside of when pushing the Buzzword Generator to receive more Buzzwords
- Buzzword Generator: the switch your ROBOT must push in order to receive more Buzzwords

FIELD Diagram:



- The Patent Office: a secret bin in between Funding Round A and Funding Round B that your ROBOT may place Buzzwords in, as alternate to Funding Round A to open the GATE
- Startup Garage: a 1’ by 1’ zone on the board where your ROBOT begins the game. Your ROBOT may be placed in any orientation in your Startup Garage.
- FIELD: the board on which your ROBOT will play the game
- Startup: your team of dynamic, disruptive, design-centric, world-class innovators